

Fruit and Fruit Products as Functional Foods

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ABSTRACT

Fruits constitute an important part of the human diet. They are one of the main food resources that humans need to ingest daily. Most fruits are consumed fresh with little preparation. Approximately half is processed for year round consumption. Some fruit products are consumed directly as foods, while some are used as ingredients in confectionery, bakery, and diet foods. Some are also used in pharmaceuticals products. Health authorities, medical practitioners, and nutritionists in recent years have repeatedly urged people to consume a generous portion of fruits and vegetables in their daily diet. Many components in fruits such as carotenoids, flavonoids, polyphenols, isothiocyanates, and fiber have been demonstrated to confer health benefits such as antimutagenicity, antioxidation, and inhibition of tumor promotion. Some of the health benefits from various functional components of more than 50 different fruits described here are based on time-honored tradition and observations, and some based on scientific studies and discoveries. The key point is that all fruits and their products are a good source of vitamins (Vitamin C and carotenoids), antioxidants (flavonoids, polyphenols) and fiber.

Key words: Fruits, Functional Foods.

INTRODUCTION

Most Asian countries are located in the tropical, subtropical, and temperate zones. In these regions, agriculture dates back several thousand years, with fruits as one of the major sources of food and nutrition. There are many varieties of fruits that grow abundantly in different regions. Many of them are eaten fresh or processed into products. Different end products, such as dried fruits, jam, marmalade, juice, preserves, pickles, puree, canned products, and many other forms such as whole, slices, pieces, bars, powders, flakes, or leathers have been available in the market for a long time. In traditional diet and medicine, fruits are used not only as foods, but also for medicinal purposes. Some fruits and their products have been used historically as natural materials to maintain health and to prevent or cure diseases for humans.

Health authorities, medical practitioners, and nutritionists in recent years have repeatedly urged people to consume a generous portion of fruits and vegetables in their daily diet. Many components in fruits such as carotenoids, flavonoids, polyphenols, isothiocyanates, and fiber have been demonstrated to confer health benefits such as antimutagenicity, antioxidation, and inhibition of tumor promotion. Increased consumption of fruits improves protection against oxidative damage that may play a role in carcinogenesis and some chronic diseases, namely oxidative DNA damage and lipid peroxidation. Modern epidemiological studies have demonstrated that fruit consumption reduces risks of certain forms of cancer, especially cancers of the gastrointestinal tract [1,2]. Because fruits are rich in substances with antioxidant activity, it has been proposed that the antioxidant properties of fruits are responsible for maintaining human health.

Presented below are few fruits, and several forms of

preserved fruits and fruit products that have various functional components believed to be helpful to the human body. Some of the statements are derived from tradition and observations, and some are based on scientific studies. Not all the benefits of these functional components have been scientifically or clinically proven, but many of the results have been observed and carried from generation to generation, some over a period of a thousand years or more. The fact remains that consuming fruits is healthy, and causes no harm. Its implied safety is in line with the concept of GRAS (generally regarded as safe), long adopted by the U.S. Food and Drug Administration.

FRUIT PRODUCTS

Annatto Fruits

The annatto (*Bexar Oreland* L.) is cultivated in many tropical countries in Asia. The fruits inside are generally found in cavities containing 10 to 50 small seeds, about the size of grape seeds. The seeds are covered with a thin, highly colored, and orange to red resinous layer from which the natural color is obtained. The main application of annatto fruits is for coloring cheese and other dairy products such as ice cream, butter mixes, yogurt, meat (sausages), fish margarine, snacks, dressings, sauces, and confectionery. Among the naturally occurring colorants, annatto colorant ranks second in economic importance after caramel.

Around 80% of the carotenoids in annatto consist of bixin, a diapocarotenoid that contains 24 carbon atoms in the skeleton and a (Z)-double bond. Also norbixin, the corresponding dicarboxylic acid with the (all-E)-configuration has been isolated. It is well established that the carotenoids possess a wide range of biological activities, with potential health benefits. Some minor carotenoids in annatto and some 15 minor compounds have been identified recently [3].

Apples

Apples (*Malus sylvestris*) are grown in China, Korea, Japan, and India. Most of apples are eaten fresh. Fresh apples can be made into puree, then dried and grounded into powder. Apple powder is a special product used mainly in the treatment of infant diarrhea. Apple pectin in apple powder has a strong bacteriostatic action on *Staphylococcus aureus*, *Streptococcus faecalis*, *Pseudomonas aeruginosa*, and *Escherichia coli* [4]. Eberhardt et al [5]. suggested that the strong inhibition of tumor cell proliferation *in vitro* could be due to apples' combination of phytochemicals (phenolic acids and flavonoids), as these are natural antioxidants. Apple pectin inhibits azoxymethane (AOM)-induced colon carcinogenesis. Therefore, apple pectin may be expected to have a strong influence on the intestinal microflora and bacterial enzyme activities. The same intestinal bacteria may reportedly play a significant role in the pathogenesis of colon cancer because their enzymes are important in the metabolism of procarcinogens, and the production of tumor promoters in the colon [6].

Apple pectin has a stronger bacteriostatic action against pathogenic bacteria than citrus pectin. The induction of colon neoplasia by AOM is dose-dependently inhibited by apple pectin. Fecal tryptophanase activity tends to decrease in the apple pectin group compared with that in the control group. The reduced level of tryptophan metabolites in the colon might be related to the inhibitory effect of apple pectin on colon carcinogenesis [4]. Apple pectin exerts an antitumor effect and prevents cancer metastasis and carcinogenesis by modifying host immune function, and altering the intestinal flora. The inhibition of hepatic metastasis by oral administration of apple pectin (apple powder) suggests it may be effective for the prevention of hepatic metastasis and residual cancer cells remaining after surgery.

Aronia Fruits

Aronia (*Aronia melanocarpa* Michx.) trees are organically grown as a hardy plant, and aronia berries are not attacked by insects. Aronia trees grow as high as 6 feet, and the dark-colored berries are picked in late August or early September. Aronia berries contain one of the highest concentrations of anthocyanin pigments of any cultivated plant. The pigment is located throughout the berry. The majority of the anthocyanin pigment remains with the pomace when the juice is squeezed. Thus, this waste product is an excellent source of anthocyanin pigments.

Aronia berries contain four kinds of anthocyanins. All of the anthocyanins identified are 3-substituted monoglycosides and they are present in the following percentages, galactose (68%), arabinose (28%), glucose (1.5%), and xylose (2.5%) [7]. Only two of these compounds (galactose and arabinose) account for more

than 95% of the material. The anthocyanins obtained from aronia provide one of the least complex mixtures found in the plant kingdom.

Aronia fruits (chokeberry) provide a healthy fruit beverage and are a natural colorant. Aronia berry juice has an astringent taste, very similar to that of cranberry and black currant. Aronia berry is rich in vitamins, minerals, antioxidants, and other health-beneficial materials. Aronia juice concentrate is attractive to consumers. The aronia beverage is high in flavonoids, specifically condensed tannins and anthocyanins, and is considered beneficial to human health.

Avocados

Avocados (*Persea Americana* Mill.) are commercially grown in the Philippines, Hawaii, and Israel. People usually prefer the avocado fruits sweetened with sugar, or combined with other fruits such as pineapples, oranges, grapefruits, dates, and bananas. Avocados have a high lipid content of 5 to 25%. Among the saturated fatty acids the myristic level may be 0.1%, palmitic 14 to 21%, and stearic 0.6 to 1.7%. The oil in the flesh is rich in Vitamins A, B, G, E. The fruit peel is considered as an antibiotic for vermifuge and a remedy for dysentery.

Bananas

Bananas (*Misa acuminata* Colla.) are grown in the humid tropical regions and constitute one of the largest fruit crops of the world. India is the leading banana producer in Asia. Other producers are Taiwan, Indonesia, and the Philippines. Most of bananas are eaten fresh. Some are dried in various forms such as banana powder and some are made into puree. Diced banana products are used as raisin substitutes in food ingredients. They can be eaten as a snack food or used in making fruit cake and bakery products. Banana puree is by far the most important processed product from the pulp of ripe fruits. The puree has a creamy white to golden yellow color, free from musty or off-flavors. Banana puree is an important infant food. Puree canned in drums by the aseptic canning process is a new product for the baking and ice cream industry.

All parts of banana fruits, peel and flesh, have medicinal applications. Banana pulp soup is taken to control dysentery and diarrhea and also used for treating malignant ulcers. Antifungal and antibiotic principles are found in the peel and pulp of ripe bananas. Norepinephrine, dopamine, and serotonin are also present in the ripe bananas, which give bananas a functionality in elevated blood pressure and inhibiting gastric secretion and stimulating the smooth muscle of intestines [5].

Bilberries

The bilberry (*Vaccinium myrtillus* L.) is a low growing shrub native to Asia and northern Europe. The small dark blue fruit is eaten fresh or made into juice and preserves.

The dried berries can be used as snacks. Bilberries can be used as a colorant for several food products. Bilberry juice is one of the most antimutagenic fruit products and is effective in reducing mutagenicity caused by the polycyclic aromatic hydrocarbons [9].

Gallic acid, an astringent, and an unusual phenolic acid, melilotic acid are identified in bilberry fruits and leaves. Other phenolic compounds are also found in the plant. Bilberry fruits contain flavonoids (quercitrin, isoquercitrin, hyperoside, avicularin, meratine, and astragaline), catechin, tannis, oligomeric proanthocyanidins, iridoid monoterpenes (asperuloside and monotropein), phenolic acids (chlorogenic, salicylic, and gentisic), quinolizidine alkaloids (myrtine, epimyrtine and occasionally arbutine), and some pectin [10]. Bilberries have a wide range of fiber values on a fresh weight basis: insoluble dietary fiber 1.9 to 3.2%, soluble dietary fiber 0.4 to 1.1%, total dietary fiber 2.3 to 3.9%. [11]. Bilberry fruit and leaves are used for a variety of medical conditions. The functional components of bilberry products appear to be the phenolic compounds, particularly the anthocyanins. Several anthocyanins are found in the fruits. The pigments are located primarily in the skin of the berries.

Morazzoni and Bombardelli [12] reviewed the history of medical uses for bilberries from the Middle Ages to the present. Surveys of 1,994 cases found 183 products containing bilberry extract as an ingredient [13]. Bilberry anthocyanins also reduce platelet aggregation *in vitro*. Anthocyanin extracts inhibit porcine elastase *in vitro*. The fruits of bilberry are used to treat many conditions resulting from diabetes. The high levels of glucose in the blood of diabetics trigger many deteriorative events in the body. Bilberry extract is believed to help improve eyesight, particularly night vision. This health benefit is the primary reason for the product's popularity in Japan and Korea [15]. Anthocyanins are important for regeneration of visual purple [16]. Bilberry extracts appear to benefit vision in several ways: improving night vision by enhanced regeneration of retinal pigments, increasing circulation within the capillaries of the retina, inhibiting of Maillard reactions in the lens to reduce cataract formation, and protection from ultraviolet light [16].

The antioxidant properties of bilberry extracts may be responsible for these health benefits. Antioxidants have been suggested to retard oxidation in the lens and slow retinal angiopathy that occurs in age-related macular degeneration and diabetic retinopathy [17]. Tannins in bilberry are considered to be responsible for their ability to treat acute diarrhea and mild inflammations of the mouth and throat [18].

Black Prunes

The black prune (*Prunus armeniaca*, Thunb.) is also

known as the Japanese apricot. The fruit is sour and tart to taste. Major chemical components are glucoside prudenin, malic acid, and succinic acid [19]. Some of its medicinal functions are to act as an astringent, antipyretic, and vermifuge, to stimulate contraction of the muscles of intestinal parasites and gallbladder, and to cause relaxation of the bile duct [20]. It is also an antimicrobial agent. People usually use it for the treatment of chronic diarrhea and dysentery, feverish thirst, achlorhydria, no appetite, residue coughing, chronic malaria, biliary ascariasis, hookworms, abdominal pain, cholecystitis, and gallstones. The fruits are commonly preserved as snack foods, or made into a beverage or wine.

Carambolas

The Carambola (*Averrhoa carambola* L.) is originated in Sri Lanka. The common name is "star fruit" due to its shape when cut in cross section. The major production areas are in East Asia, including Indonesia, Malaysia, Sri Lanka, Taiwan, the southern part of China, and Vietnam. There are two distinct cultivars: sweet and sour cultivars. The sour cultivar is rich in flavor, with more oxalic acid [8]. The sweet cultivar is mild flavored, rather bland, with less oxalic acid. The sweet cultivar is used for fresh consumption and juice processing, while the sour cultivar is processed into jam, jelly, canned fruits, sweetened nectar, or other preserves. Juice products are by far the most important processed commodities of carambola fruits.

Fermented carambola juice is a traditional health drink in China and India. It is served as a cooling beverage, and good for soothing some uncomfortable body conditions, such as to quench thirst, increase the salivary secretion, and allay fever. The fruit pulp is considered to allay biliousness and diarrhea, and relieve a hangover from excessive indulgence in alcohol. In India, the ripe fruit is used to halt hemorrhages and to relieve bleeding hemorrhoids. Carambola is recommended as a diuretic in kidney and bladder complaints, and is believed to have a beneficial effect in the treatment of eczema [8].

Cherimoyas

Cherimoya (*Annona cherimola* Mill.) is growing in the Philippines, India, and Sri Lanka. The flesh of ripe cherimoya fruits is most commonly eaten out of hand. Fruits also can be made into juice and salad, or fermented into alcoholic beverage, or dried into powder. The cherimoya fruit's powder is used to kill lice and is applied on parasitic skin disorders, and also to relieve pneumonia [8].

Chinese Dates

Chinese dates (*Zizyphus vulgaris* var. *spinosa*) are grown in the Hunan, Shandong, Zhejiang, and Shanxi provinces of China. Chinese dates are dried in the sun, or by dryers; depending on the technique used for drying,

the final dried dates products have different names: “red dates” and “black dates.” The final products have moisture levels of 18 to 20%.

1. **Red Dates:** Fully ripe Chinese dates are blanched and dried as whole fruits by the sun. The product has a dark-red color, golden-yellow meat, elastic texture, and sweet taste.
2. **Black Dates:** Fully ripe Chinese dates are selected, blanched, then dried and fumed at 60 to 70°C for 20 to 24 h. [21]. The product has a dark-violet color, wrinkled surface, sweet taste, and elastic texture.

Chinese date products have a special function in invigorating blood circulation according to Chinese traditional medicine. Some major medicinal functions are to strengthen the spleen and stomach, moisturize the heart and lungs, and regulate various medications. Chinese dates products are used for treatment of weak stomach and spleen, anemia, inadequate energy (fatigue), and salivation. Dates and rice cooked into gruel is nutritious.

Citrus Fruits

Citrus fruits are widely known to contain various types of chemopreventers such as D-limonene, limonoids and their glucosides, flavonoids, and carotenoids. Levels of auraptene vary from high (408 to 585 mg/kg fresh wt.) in the peels of natsumikan and hassaku oranges, moderate (101 to 120 mg/kg fresh wt.), and absent (<1 mg/kg fresh wt.) in the peels of the Satsuma mandarin (tangerine), Valencia orange, navel orange, lemon, and lime. The auraptene content in the sarcocarps of the above fruits is similar to that in the peels [22].

Commercial juices from natsumikan and hassaku oranges showed higher contents of auraptene (0.87 to 1.80 mg/L). Auraptene, a citrus coumarin, is an effective cancer chemopreventer. These characteristics together with high chemopreventive potency make it an appropriate source substance for the creation of physiologically functional foods. The citrus juices have hypocholesterolemic effects in heart disease [23].

Oranges

The juice of oranges (*Citrus sinensis*) grown in China, India, and Japan has a deep orange color. Orange juice concentrate is prepared from either freshly extracted and pasteurized single-strength juice or from a storage and pasteurized single-strength juice. Spraying and drum drying produce dehydrated orange juice. The final powder has less than 0.6% moisture and maintains its quality when stored at room temperature. Orange products are traditionally taken to allay fever and catarrh. The roasted pulp is prepared as a poultice for skin diseases. The immature fruits are also made into infusion (or tea) to relieve stomach and intestinal complaints [8].

Red Tangerine

Red tangerine (*Citrus reliculata* Blanco.) peels are the red-colored external layer of the pericarp. The major chemical components are citral, geraniol, linalool, methylantranilate, stachydrine, putrescine, apyrocatechol, and glucosides (naringin, poncirin, hesperidin, neohesperidin, and nobiletin) [8].

Some of the medicinal functions are to correct energy circulation, strengthen the lungs, and resolve phlegm. Red tangerine peels are used for treatment of fullness in chest and indigestion, eliminating sputum and coughing. [8] People use it as a tea, or prepare a red tangerine peel gruel made by decocting and cooking, in which the ingredients include red tangerine peel and bitter apricot kernel. The red tangerine peels can also be steamed with chicken and wine [23].

Mandarin Oranges

Mandarin orange (*Citrus reticulata*) is considered a native of southeastern Asia and the Philippines. It is now abundantly grown in China, Japan, and India. Mandarin oranges are eaten fresh, or used in fruit salads, gelatins, puddings, or cakes. The essential oil from the peel is produced commercially as a flavoring ingredient. Mandarin orange peels are dried peels that are bitter and acrid to taste. Major chemical components are bitter-tasting flavone glycosides (neohesperidin and naringin, neohesperidose), nonbitter flavonoids (hesperidin, rutoside, sinensetin, nobiletin, and tangeratin), 1 to 25 essential oils (limonene), and pectin [8]. Some medicinal functions are to correct energy circulation, strengthen the spleen, counteract excessive moisture in the body, and resolve phlegm. People often use it for easing of fullness in chest and abdomen, regurgitation and vomiting, chest and abdominal pains, poor appetite, productive coughing, indigestion, and diarrhea. It also can be used as a popular dish called mandarin orange peels beef, or as preserved fruit products to enhance the digestive system and blood circulation.

Kumquats

Kumquats (*Fortunella margarita*), also called “Golden Orange” in China, originated in Northern China, and are produced primarily in China and the Philippines, with limited production in other areas of the world such as in Southeast Asia and Japan. Kumquats are eaten fresh or are candied or cured whole, and are unique in that the entire fruit, including the peel, is generally eaten. The cured products have a golden color, translucent texture, dry surface without sugar particles, and strong fresh flavor. The cured kumquat products are usually used as confections to improve appetite [8].

Pummelos

Pummelos (*Citrus maxima* Merr.) are the largest citrus fruit, native to southeastern Asia, and are grown in China, India, Indonesia, Japan, Malaysia, Thailand,

Taiwan, and the Philippines. People like to eat the juicy pulp, which is used for salads, desserts, or made into preserves. Pummelo juice makes an excellent beverage. The pulp and peel have a sedative effect in cases of epilepsy, chorea, and convulsive coughing. Pummelo juice is taken as a febrifuge in the Philippines and Southeast Asia [8].

Cranberries

Cranberry (*Vaccinium macrocarpon* A.) products as dietary supplements are widely available in a variety of food and beverage forms. Cranberry fruits contain phytochemicals, which include flavonoids and phenolic acids with antioxidant and other physiologically beneficial activities. Classes of cranberry flavonoids include anthocyanins, flavonols, flavan-3-ols, and proanthocyanidins. Each of these classes of compounds has interesting physiological activities. Anthocyanins are the pigments that give cranberries their rich, red color. Cranberry fruits also contain ellagic acid, which has been shown to have a broad range of anticarcinogenic activities [24].

Cranberries and cranberry products have long been associated with a variety of health benefits. Cranberries appear to have a relatively unique menu of components that have interesting value in human nutrition, particularly in maintaining health and wellness. Cranberries, and particularly cranberry juice products have long enjoyed a folk reputation as a treatment for urinary tract infections. Although the low pH of the fruit is considered as the antimicrobial agent, fructose and high molecular weight phenolic compounds have been found to prevent the adhesion of *Escherichia coli* cells *in vitro* [24]. Fructose and polyphenols prevent mannose resistant adhesions on certain P-fimbriated *E. coli* isolated from attaching epithelial tissues in the urinary tract [25]. Purified cranberry proanthocyanidins are reported to possess antiadherence properties in an *in vitro* assay.^[26] It is said that cranberries can dress wounds and prevent inflammation, and were used aboard ships to help prevent scurvy, although their level of vitamin C is well below that of most citrus fruits. Cranberries are thought to help relieve the symptoms of urinary tract infections, even prevent their occurrence. Much anecdotal information is responsible for the medical myth that surrounds the fruits and their products.

Durians

Durians (*Durio zibethinu* L.) are large fruits covered with hard, hexagonal, stubby spines. It is a heavy fruit reaching the size of a honey melon. Skin of the ripened fruit turns from brown to bright yellow. Durian is a delicious tropical fruit and well known throughout Southeast Asia, Thailand, Malaysia, and South Vietnam; the southern Philippines are important producers of durians. Durian flesh is mostly eaten fresh but is also

canned in syrup, or dried, or made into paste. Durian is a good source of iron, B vitamins, and ascorbic acid. The thick, pudding-like texture of the aril is due to gums, pectin, and hemicellulose [26]. The flesh of durian is said to serve as a vermifuge. Durian flesh is also widely considered an aphrodisiac in Thailand. In India, durian products are marketed to provide energy, to keep the body vigorous and tireless, the mind alert with faculties undimmed and spirit youthful.

Embalics

Embalics (*Phyllanthus emblica* L.), native to Southeastern Asia, are grown in tropical Asia such as Bangladesh, Cambodia, India, Malaysia, Pakistan, Sri Lanka, Southern China, Thailand, Vietnam, and the Philippines. Both ripe and half ripe fruits can be canned or made into jam and juice. Embalics can be combined with other fruits in making chutney and pickles. The embalics are important in Asian traditional medicine as an antiscorbutic and in the treatment of diverse ailments, especially with the digestive organs. Embalics are often considered diuretic and laxative. The embalics pulp and juice, especially after fermentation, are helpful for indigestion, anemia, jaundice, dyspepsia, coughs, nasal congestion, retention of urine, and some cardiac problems. The embalic powder is an effective expectorant as it stimulates the bronchial glands [8].

Figs

Figs (*Ficus carica* L.) are believed to be indigenous to Western Asia, and grown in mild temperate climates, and have been commercially produced in most of the countries bordering the Mediterranean Sea. Fig flesh is usually eaten out of hand, but the fruits are also cooked in pies, cakes, bread, cookies, or ice cream. Fruits also can be prepared into jam, marmalade, and paste. They are usually sun-dried, but dehydration is also practiced to produce low-moisture fig products. Turkey is one and South Vietnam; the southern Philippines are important producers of durians. Durian flesh is mostly eaten fresh but is also canned in syrup, or dried, or made into paste. Durian is a good source of iron, B vitamins, and ascorbic acid. The thick, pudding-like texture of the aril is due to gums, pectin, and hemicellulose [27]. The flesh of durian is said to serve as a vermifuge. Durian flesh is also widely considered an aphrodisiac in Thailand. In India, durian products are marketed to provide energy, to keep the body vigorous and tireless, the mind alert with faculties undimmed and spirit youthful.

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Grapes

Grapes (*Vitis vinifera*) are processed primarily into wine, juice, raisins, and brandy. Other products include grapeseed oil, grape pomace, hydrocolloids, and anthocyanins. The components of grapes and grape products play a significant role in preventing or delaying the onset of diseases including cancer and cardiovascular diseases [28–30]. Phenolic compounds and other health-promoting compounds are secondary plant metabolites that significantly contribute to the flavor and color characteristics of grapes, grape juices, and wines. The phenolic compounds of grapes include phenolic acids, anthocyanins, flavonols, flavan-3-ols, and tannins. The flavonoids (C6-C3-C6), which include the anthocyanins, flavonols, and flavan-3-ols, are powerful antioxidants, and are found in high concentration in grapes and grape products [31]. These compounds exhibit a wide range of biochemical and pharmacological effects, including anti-inflammatory and antiallergic effects. Other grape flavonoids such as quercetin, kaempferol, and myricetin also inhibit carcinogen-induced tumors [32–34].

Grape is rich in anthocyanins, which have known pharmacological properties and are used by humans for therapeutic purposes. Applied orally or by intravenous or intramuscular injection, pharmaceutical preparations of anthocyanins reduce capillary permeability and fragility [35]. This anti-inflammatory activity of anthocyanins accounts for their significant antiedema properties and their action on diabetic microangiopathy [36]. It has also been reported that anthocyanins possess antiulcer activity, and provide protection against UV radiation [37].

Ellagic acid and resveratrol are two important components to reduce the risk of cancer and coronary heart diseases [38,39]. Ellagic acid (C₁₄H₆O₈) is an acid hydrolytic product of ellagitannin found in grape juice. Resveratrol (3,4,5-tri-hydroxystilbene), a naturally occurring phytoalexin produced in response to injury, has drawn much attention as a functional component. It is found in large quantities in grapes, and its presence in wine is thought to be responsible for the low mortality from coronary heart disease in wine-drinking populations. Resveratrol is reported to be a cancer chemopreventive agent having shown activity in assays representing three stages of carcinogenesis [40]. It

is also shown to be an antioxidant, inhibiting lipopolysaccharide or phorbol ester induced superoxide radical and hydrogen peroxide production by macrophages. In muscadine grapes, the skins have the highest concentration of resveratrol [41].

Guavas

Guavas (*Psidium guajava* L.) are grown in Malaysia, Indonesia, India, Vietnam, Thailand, South China, and the Philippines. Guava flesh is often eaten fresh as dessert and salads. Many commercial products use guava flesh in pies, cakes, puddings, sauce, ice cream, juice, nectar, jam, jelly, marmalade, chutney, relish, and other products, which may frequently be seen on the markets in India, Pakistan, and Indonesia. The products made from immature fruits are commonly used to halt gastroenteritis, diarrhea, and dysentery throughout the tropical area. It contains several glucosides including avicularin, guajavarin, and amritoside, and their hydrolyzed genin, quercetin. Fruits of *Fan Shi Liu* exhibit antidiarrheal and antibacterial effects, which are spasmolytic, chiefly from the effect of the glucosides and their genin and quercetin [42]. The fruit has a slight antihyperglycemic effect [43].

The water-based extract also exerts an antimutagenic activity and can counteract the mutagenicity of the direct action of mutagens [44]. The fruit is used to treat dysentery and acute gastrointestinal inflammation.

Hawthorn Fruits

Hawthorn fruits (*Crataegus pinnatifida* Bge.) are grown in China. Hawthorn has long been used to make candies in China. It can be consumed as a snack food such as hawthorn cookies and hawthorn cake. Hawthorn fruits have a sweet sour taste, and a fresh flavor. The dish of sweet and sour pork with hawthorn is considered a medicinal food, in which hawthorn and licorice are first cooked. It is also used as a sauce for deep-fried pork [45]. The fruit contains chlorogenic acid, caffeic acid, phlobaphene, L-epicatechol, choline, choline acetate, β -sitosterol, sorbitol, vitamin C, crategolic acid, hyperin, tartaric acid, citric acid, and certain chromones. Hawthorn is a rich source of the flavan-3-ol (-)-epicatechin and proanthocyanidins related to (-)-epicatechin, e.g., epicatechin- (4 β →8) - epicatechin (procyanidin B2) [20].

This fruit has also long been used in Chinese herbal medicine to provide one of the best tonic remedies for the heart and circulatory system, and for treating swelling. Hawthorn fruits are said to control blood stasis, relieve pains associated with swelling, promote digestive function, and mitigate other conditions, especially in reducing blood pressure. Some of the pharmacological activities, e.g., the hypotensive effects, have been attributed to the chromones [19]. They act in a normalizing way upon the heart, depending on the need,

stimulating or depressing its activity. The major medicinal functions are to help digestion, stimulate blood circulation, stop diarrhea, lower blood cholesterol, smooth the surface of the atherosclerotic area, increase blood flow in heart, increase the myocardial contractibility, and lower blood pressure [20].

Hawthorn products are usually used for treatment of indigestion, infantile marasmus, menstrual cramps, diarrhea, dysentery, hernia, hypercholesterolemia, angina pectoris, and hypertension.^[20] It is often used as a cardiac tonic, and the blossoms are also effective [46].

Recently a study on 104 hypercholesterolemic patients demonstrated that a daily dose equivalent to 46 g of the fruit for 45 days caused normalization of cholesterol value in 75% of the patients, with an additional 15% of the patients experiencing a 20 milligrams/deciliter (mg/dl) reduction. Daily supplementation of an extract of the fruit (equivalent to 15 g fresh fruit daily) for 12 weeks in 16 coronary artery patients with angina led to outstanding improvement in the conditions of most of the patients, including normalization of exertional electrocardiogram and resting electrocardiogram. There were also substantial reductions in serum triglycerides and cholesterol [47]. Oral supplementation of extracts of the fruit showed effectiveness in lowering blood pressure in hypertensive patients.^{48,49} In addition to these human studies, many animal studies also demonstrated that the hawthorn fruits and their extracts can reduce heart muscle fatigue, strengthen the heart muscles, contraction amplitude and pumping power, dilate the coronary artery, and enhance blood supply to the heart muscles [20]. Extracts of hawthorn fruits are now sold in world markets as a health food or cardiac tonic.

Indian Jujubes

Indian jujubes (*Zizyphus mauritiana* Mill.), with other names such as Indian plum, Indian cherry, and Malay jujube, are grown in India, Indonesia, Malaysia, Southern China, Thailand, and the Philippines. The ripe fruits are usually eaten raw, or stewed. Some canned products, juice, and dried powder are also available in the markets. The fruits are traditionally used for cuts and ulcers, for pulmonary ailments and fevers. The dried fruit powder is a mild laxative. Sometimes the fruit pulps are blended with salt and chili for indigestion and biliousness [48].

Jackfruits

Jackfruits (*Artocarpus heterophyllus* L.) are produced in the Philippines, Malaysia, Thailand, Cambodia, Laos, and Vietnam. Fruit flesh can be made into ice cream, chutney, jam, jelly, paste. Firm types of jackfruits are preferred for canning. Products more attractive than the fresh pulp are called ‘vegetable meat.’ The fruits also can be dried. The Chinese consider jackfruit pulp a nutritious tonic, cooling and nutritious, and effective in overcoming

the influence of alcohol in humans [8].

Kiwifruits

Kiwifruits (*Actinidia chinensis* Planch.), with a Chinese name “gooseberry” or “Yang Tao,” are grown in the Yangtze River valley. Kiwifruits are rich in Vitamin C and usually eaten fresh, or used as appetizers, in salads, pies, pudding, and cakefilling. Quinic acid predominates in young fruits, then disappears with the formation of ascorbic acid. Kiwifruits contain the proteolytic enzyme actinidin that is said to aid digestion [49].

Kiwifruit flesh is also rich in folic acid, potassium, chromium, and Vitamin E. Kiwifruit juice of optimal flavor is produced from ripe fruits of sound quality. With other fruit juice, a sparkling kiwifruit juice can be made by carbonation [21, 50]. In China, the fruit juice is valued for promoting expulsion of the kidney or gallstone [19].

Loquats

Loquats (*Eriobotrya japonica* Lindl.), also called Japanese plums, probably originated in China, and are adapted for a subtropical to mild temperate climate. Today China, India, Israel, and Japan are the leading producers of loquats. Loquats are usually eaten fresh. Japan, Taiwan, and Israel have exported canned loquats in syrup to the world markets. Canned loquats are consumed largely as dessert fruits. Canned products retain a golden color and fresh flavor. The fruits are also used in gelatin desserts, as piefilling, or chopped and cooked as a sauce. The loquat products are traditionally considered to act as a sedative and are taken to halt vomiting, quench thirst, or relieve coughing [8].

Longans

Longan (*Euphoria longan* Lour.) fruits are produced in Southern China, Taiwan, India, Thailand, Cambodia, Laos, Vietnam, Malaysia, and the Philippines. Longans are mostly eaten fresh. The dried products are black, leathery, and smoky in flavor. They are mainly used in the making of infusion beverages. The main chemical components in Longans are vitamin B, glucose, sucrose, and tartaric acid. The fruit products can be administered as a stomachic, febrifuge, and vermifuge, and are regarded as an antidote for poison. A decoction of the dried flesh is traditionally taken as a tonic and treatment for insomnia and neurasthenic neurosis [5]. Some major medicinal functions are to nourish the spleen, cultivate the heart, and supplement the intellect. Traditionally the fruit products are used for anemia, hyperactive mental activity, and forgetfulness [19].

Litchi

Litchi or lychee (*Litchi chinensis* Sonn.) originates in the Guangdong province of China and has been grown in China for more than 4,000 years. The Guangdong and Fujian provinces in southern China remain the

largest producers of litchi, followed by Vietnam, Thailand, India, Burma, Japan, the Philippines, Taiwan, Pakistan, and Bangladesh. Dried litchi fruits, frequently referred to as “lychee nuts,” or “litchi nut,” offer interesting opportunities in domestic and foreign markets. During drying, the pericarp or outer skin gradually loses its original color and becomes cinnamon-brown and brittle, while retaining its shape. The pulp turns dark-brown to nearly black as it shrivels around the seed and becomes very pleasant in flavor and raisin-like in texture. Litchi are most relished fresh. Pureed litchi are added to ice cream and hot milk. Canned litchi in sugar syrup has been exported from China and India for many years. Ingested in moderate amounts, litchi are traditionally taken to relieve coughing and have beneficial effects on gastralgia, tumors and enlargements of glands. Fermented litchi are also used in the Chinese medicine [8,19,20].

Mangoes

Mangoes (*Mangifera indica* L.) are originally from the Indo Malaysian region. The earliest growing area was Northeastern India and Burma eastward to Indochina. The production of mangoes later extended into many Asian countries and regions such as Southern India, the Philippines, Indonesia, China, Thailand, Malaysia, Sri Lanka, and Israel. India, the Philippines, Pakistan, and Thailand are the leading exporters of processed mango products.

Most people enjoy eating mango flesh as appetizers or dessert. The ripe flesh may be spiced and preserved in jars or canned in syrup, or made into jam, marmalade, jelly, or nectar. Dried mangoes are utilized commercially as a substitute for the mangoes used in chutney manufacture. Dried slices are prepared from ripe fruits. The peeled or unpeeled slices of raw mango are dried in the sun or in a cabinet dryer, then turned into powder used as a souring agent in Indian cuisine. Mango juice has a red-yellow color, and high in fresh like flavor. Mango juice powder is used in infant and invalid foods. Mango products have the medicinal properties of a laxative, diuretic and a fattening agent according to traditional medicine. Mango juice has a cooling effect and is used during hot weather in the North Indian region. It is also alleged to help cure cholera and plague. Dried mango peel and flowers, containing up to 15% tannins, can be used as astringents in cases of diarrhea, chronic dysentery, catarrh of the bladder, and chronic urethritis resulting from gonorrhea [8].

Mangosteens

Mangosteens (*Garcinia mangostana* L.) are grown in Burma, India, Malaysia, Sri Lanka, Thailand, the Philippines, and Vietnam. The mangosteen flesh is often eaten fresh as dessert. The flesh amounts to 31% of the fruits. The fruit flesh contains phytin up to 0.68% on a dry basis. The flesh is canned, or made into jam in

Malaysia and the Philippines. The dried fruit powder is used to overcome dysentery in traditional medicine, and is also applied on eczema and skin disorders, to relieve chronic diarrhea, cystitis, gonorrhea, and gleet, it is sometimes used for astringent lotion [8].

Mulberry

Mulberry (*Morus alba* L.) is grown in subtropical areas. Mulberry is sour and tart, yet has a pleasant taste. Some chemical components such as morin, dihydromorin, dihydromorin, dihydrokaempferol, 2, 4, 4', 6-tetrahydroxybenzophenone, maclurin, mulberrin, mulberrochromene, and cyclomulberrochromene have been isolated from mulberry [19, 20]. Major medicinal functions are to strengthen kidneys, aid vision, and nourish blood. People use it for treatment of agitation and insomnia, deafness and blurred vision, white patches in hair and beard, hot intestines and constipation, pain in back and knees, and stiffness of muscles and joints. Famous mulberry gruel is made with mulberry fruits, rice, chicken, and other ingredients, including red *jujubes*, lotus seeds, and pine seeds. The congee is very effective for bronchitis, sinusitis, and asthma. It is said to strengthen the lungs and is used as an antitussive [51]. Mulberry is also processed into fruit beverage.

Papayas

Papayas (*Carica papaya* L.) are grown in Hawaii, India, Malaysia, Sri Lanka, Thailand, and the Philippines. Ripe papayas are most eaten fresh. The ripe flesh is usually made into sauce, or pickled, or preserved as marmalade and jam. Papaya flesh is rich in carotenoids. The major carotenoid is cryptoxanthin [8]. Papaya flesh is also prepared into juice, puree, and nectar. Papaya juice is extracted, then prepared into nectar, a ready to drink beverage. Papaya juice has a deep, rich orange color, and contains papain. It is also high in vitamin A and C, and is considered a “health food.” Papaya juice concentrate is commonly sold to hospitals and health food stores in the Philippines.

Passion Fruits

Passion fruits (*Passiflora edulis* Deg.) are grown in Southern Asia. Passion fruit juice, due to its unique intense flavor, high acidity, and yellow/orange pulp, has been described as a natural concentrate. Passion fruit juice makes a highly palatable beverage when sweetened and diluted. India, Sri Lanka, Indonesia, Thailand, Malaysia, Taiwan, and the Philippines are important sources of passion fruit products in the world market. The yellow flesh has less ascorbic acid than that in the purple flesh, but is richer in total acid (mainly citric acid) and carotene content. Carotenoids in the flesh are 0.6 to 1.16% [8].

The flesh is a good source of niacin and riboflavin.

The juice can be sweetened, and then diluted with water

or other fruit juices, to make cold drinks. Passion fruit juice can be concentrated, then used in the making of sauces, gelatin desserts, candy, ice cream, sherbet, cake filling, meringue or chiffon pie, cold fruit soup, and cocktails. The frozen juice can be kept for 1 year, and is a very appealing product. The juice can also be dehydrated using a freeze-dryer or vacuum-dryer process. According to Chinese traditional medicine, passion fruits (or dried powder) can be prescribed for insomnia, convulsions, nervous breakdown, menopause, fevers, tension, and high blood pressure. It is rich in the nutrient complexes, especially calcium and magnesium. The juice is taken as a digestive stimulant, and used in treatment for gastric cancer. There is currently a revival of interest in the pharmaceutical industry in the use of glycosides as sedatives or tranquilizers [8].

Persimmons

Persimmons (*Diospyros kaki* L.) are grown all over Asia. Japan is the largest producer and *Kaki* is its popular name in Japan. Other persimmon-producing countries are China, Israel, the Philippines, Indonesia, India, Burma, Vietnam, and Korea. The fully ripe persimmons are usually eaten fresh. The flesh may be added to salads, blended with ice cream, yogurt, cakes, cookies, desserts, puddings, jam, or marmalade. The Japanese dry large quantities of persimmons, which are used as confection or food. Dried persimmon products have white “persimmon sugar” on the surface, with a soft texture, and a sweet taste. Large quantities of persimmons are preserved by drying in the sun. The dried products are flattened into form by pressing, sugar crystals then appear on the surface. In Indonesia, ripe fruits are stewed until soft, then pressed flat and dried in the sun. In Israel, the intestinal compaction from consumption of persimmons has been eliminated by drying the fruits before marketing, and some dried fruits are now being exported to Europe. A decoction of the calyx and fruit products is traditionally taken to relieve hiccups, coughs, and labored respiration in Asian countries [8].

Pineapples

Over the past 100 years, pineapple (*Ananas comosus* Merr.) has become one of the leading commercial tropical fruits in the world. Major producing areas are Malaysia, Hawaii, Taiwan, the Philippines, and Thailand. Field ripe fruits are best eaten fresh. The flesh of pineapples is cut in pieces and eaten fresh as dessert, in salads, or cooked in pies, cakes, puddings, or made into sauces or preserves. In Malaysia, pineapples are used in curries and meat dishes. In the Philippines, the fermented pineapple pulp is made into a popular sweetmeat called *nata de pina*. Much of the Asian-grown pineapples are canned and are an important value-added product in world markets. The chief sources of the world’s canned pineapple and pineapple juice are Bangladesh, India, Malaysia, Taiwan, Thailand, and the Philippines. Thailand is the leading producer and exporter in the

world canned pineapple product market. There is a growing demand for pineapple juice. Pine- apple juice, nectar, and concentrate are now commercially prepared. Pineapple juice as syrup is used in confections and beverages, or made into powder. Pineapple juice is traditionally taken as a diuretic and to expedite labor, also as a gargle in cases of sore throat and as an antidote for seasickness [52].

Pomegranates

The pomegranate (*Punica granatum* L.) is a subtropical fruit native to the Middle East. It has long been cultivated in the Middle East, the Mediterranean region, and other areas in Asia. The most important pomegranate growing regions are China, Afghanistan, Pakistan, Bangladesh, Iran, Iraq, India, Burma, and Saudi Arabia. There are some commercial orchards in Israel on the coastal plain and in the Jordan Valley. People like sucking the fruit sacs from the fresh pulp of pomegranates. In some countries, pomegranate juice is a very popular beverage. An attractive colored juice (purplish red), large juicy grains, mild acid sweet taste, and tannin content of not more than 0.25% are the qualities desired in the fruits used for the juice processing. For beverage purposes, the juice is usually sweetened. In Saudi Arabia, the juice sacs may be frozen intact or the extracted juice may be concentrated and frozen for future use. Pomegranate juice is widely made into grenadine syrup for use in mixed drinks. It is also made into thick syrup for use as a sauce.

Pomegranate is a source for antioxidants considered to be antiatherogenic. The juice is rich in citric acid and sodium citrate, which can be used for pharmaceutical purposes. Pomegranate juice has been used for treating dyspepsia, and is considered beneficial in leprosy. Recent *in vitro* studies demonstrated a significant dose-dependent antioxidant capability of pomegranate juice against lipid peroxidation in plasma (by up to 33%), in low-density lipoprotein (by up to 43%), and in high density lipoprotein (by up to 22%) [53]. Pomegranate juice not only inhibited low-density lipoprotein oxidation, but also reduced two other related modifications of the lipoprotein, i.e., its retention to proteoglycan and its susceptibility to aggregation [54]. The antioxidative effects of pomegranate juice against lipid peroxidation in whole plasma and in isolated lipoproteins have been also shown *in vivo* in humans. Pomegranate juice consumption by humans increases the activity of their serum paraoxonase, which is high-density lipoprotein-associated esterase that acts as a potent protector against lipid peroxidation.

Sea Buckthorn Fruits

Sea buckthorn (*Hippophae rhamnoides* L.) is distributed widely throughout the Himalayan regions in Asia, and usually on river banks and coastal dunes along the Baltic Coast and on the Western coast along the Gulf of

Bothnia. Sea buckthorn is a unique and valuable plant species currently being domesticated in various parts of the world. Sea buckthorn fruits are yellow or orange berries, rich in carbohydrates, protein, organic acids, amino acids, and vitamins. The contents of these components vary with fruit maturity, fruit size, species, and geographic locations (Table I).

TABLE I: Some Functional Components of Sea Buckthorn Fruits

Component(s)	Content
Carotene and carotenoids	16-28mg/100 g
Fruit Flavonoid (fruit)	120-2100mg/100 g
Fruit Volatile oil	3.6 mg/100 g
Fruit Saturated fatty acid (fruit)	47.0%
Unsaturated fatty acid (fruit)	53.0%

Medicinal uses of sea buckthorn are well documented in Asia. The most important pharmacological functions attributed to sea buckthorn oil include antiinflammatory, antimicrobial, pain relief, and the promotion of tissue regeneration. Sea buckthorn oil is also recommended as a treatment for oral mucositis, rectum mucositis, vaginal mucositis, cervical erosion, radiation damage, burns, scalds, duodenal ulcers, gastric ulcers, chilblains, skin ulcers caused by malnutrition, and other skin damage [55, 56]. Sea buckthorn oil extracted from seed is popular in cosmetic preparations, such as facial cream. According to the recent report from China, in a study with 350 patients, beauty cream made with sea buckthorn oil had positive therapeutic effects on melanosis, senile skin wrinkles, and freckles [57]. More than 10 different functional foods have been developed from sea buckthorn fruits in Asia such as liquids, powders, plasters, films, pastes, pills, liniments, suppositories, and aerosols. Other products made from sea buckthorn include beverages and jam from fruits and fermented pulp products.

Santol Fruits

Santol fruits (*Sandoricum koetjape* Merr.) are grown in Cambodia, India, Indonesia, Laos, Malaysia, Thailand, Vietnam, and The Philippines. The fruits are abundant in the local markets. The fruits are usually eaten fresh, sometimes with spices in India. The fruits are also made into jam, jelly, marmalade, or canned, after removing the seed and peeling. The preserved pulp is used for medicinal purposes as an astringent [8].

Soursop Fruits

Soursop (*Annona muricata* L.) fruits are the largest tropic fruits, and are very common in the markets of Malaysia, Thailand, the Philippines, and Southeast Vietnam. Soursop fruits are eaten fresh, or in refreshing juices throughout the tropical area. The pulp is made into tarts,

jelly, syrup, and nectar. The strained and frozen pulp and canned vacuum- concentrated juice are commercial products in the Philippines. The juice of the ripe soursop fruits has a diuretic function and is considered a remedy for hematuria and urethritis. It is also believed that juice can relieve liver ailments and leprosy [8].

Tamarinds

Tamarind (*Tamarindus indica* L.) fruits are grown in Cambodia, India, Laos, Malaysia, the Philippines, and Vietnam. The pulp is rich in calcium, phosphorous, iron, thiamine, riboflavin, and niacin. The fully ripe fresh fruits are relished and eaten fresh. The tender, immature, and sour pulp is cooked as seasoning with rice, fish, and meats in India. The acid-sweet pulp is also blended with sugar to make into confection, sauce, jam, or nectar. In Southeast Asia, some people use the tamarinds to counteract the ill effects of an overdose of false chaulmoogra. Tamarind pulp is considered useful in the restoration of sensation in cases of paralysis [8].

Wolfberry

Wolfberry (*Lycium Chinense* Miller.) is grown in subtropical areas. Wolfberry is pleasant to taste. Major chemical components are betaine, zeaxanthin, physalein, and vitamins (carotene, nicotinic acid, and vitamin C) [19, 20]. Major medicinal functions are to strengthen the kidneys, restore semen, nourish the liver, and clear vision. People usually use it for treatment of nutritional deficiency, eye diseases, diabetes, inadequate liver and kidney function, and seminal emission. A dish called pork kidney with wolfberry (other ingredients include squid and lycium bark) can energize the body and supplement the blood. It can be a mild treatment for diabetes and vision defects [58]. Wolfberry can also be cooked with chicken or rice [51]. It can be decocted as a tea for drinking.

Miscellaneous Fruits

Fruits of *Prunus mume* Sieb. et Zucc. (Wu Mei)

Fruits of *Prunus mume* Sieb. et Zucc. (With Chinese name *Wu Mei*) are harvested just before ripening while it is still green, then baked dry at a low temperature. The finished product is black colored and extremely sour. Fruits are very rich in the glucoside prudomenin, malic acid, and succinic acid. The dried fruit is used to impart tartness and flavor in preparing beverage drinks in China. The fruit infusion is commonly used to treat biliary ascariasis and hookworm. The fruit can stimulate contractions of the muscles of intestinal parasites and of the gall bladder, but causes relaxation and beneficial in purging ascaris from the bile duct and intestine [20]. The fruits are also used in the treatment of cholecystitis and gallstone disease. Concoctions of the fruits have been used to treat neoplasia like conditions [51].

Fruits of *Trichosanthes Kirilowii maximi*

Fruits of *Trichosanthes kirilowii maximi*, quashlike

fruits, are important material for treating neoplasia and many other conditions, particularly at the early stages of cancer. An extract of the fruit skin has been shown to be a potent cytocide against cultured cancer cells [59]. One of the active principles was identified as a small protein, trichosanthin. The fruits also contain many phenolic compounds and alkaloids.

Fruits of *Lycium Chinense* Mill. (*Gou Qi Zi*)

Fruits of *Lycium Chinense* Mill. (with Chinese name as *Gou Qi Zi*) are bright red colored fruits, and have long been a tonic herb in China. The fruit contains betaine (0.1% of dry basis), and zeaxanthin, physalein, vitamins such as carotene, nicotinic acid, and vitamin C [19, 20]. The effects of the fruits include an increase in leukocyte count and nonspecific immunity, and stimulation of tissue development [20]. The infusion of fruits can increase the plasma level of tumor necrosis factor and interleukin-1 in human blood, and can also lower blood pressure and stimulate the heart. *Lycium Chinense* Mill. Fruit, as a cool type herbal medicine, is used to treat certain types of inflammatory conditions and hypertension. It is also used in tonic soups and alcoholic drinks [19, 20]. The extract of *Lycium Chinense* Mill. Fruits enhance phagocytotic activity of immune cells and promote white cell formation. The fruit infusion can be a mild treatment for diabetes and vision defects. The fruits can be cooked with meat, rice, or used as tea.

Fruits of *Schisandra chinensis*

In China, the dried, purplish-black berry of *Schisandra chinensis*, about a few millimeters in diameter, is used both as a flavoring agent in food and beverage, and also as a medicine. One of the most important modern uses of this berry is in the treatment of bacterial and viral chronic hepatitis and xenobiotic induced hepatitis. *Schisandra* berries are used in combination with other herbs to treat excessive sweating, certain types of bronchitis and asthma, and other conditions. Modern studies suggest that it has CNS stimulation effects (77AA). The berry contains many active compounds such as schizandrin, deoxyschizandrin, γ -schizandrin, pseudo- γ -schizandrin, schizandrol, α -chamigrene, chamigrenal, phytosterols, citral, and vitamins C and E [60]. The berry has been used in China for promoting health according to traditional Chinese medicine. Now tablets and powders of *Schisandra* berry have been marketed widely as nutritional supplements for promoting health.

Fruits of *Emblica officinalis* Gaertn

Fruits of *Emblica officinalis* Gaertn have been used extensively as the main ingredient to prevent colds, coughs, and enhance immunity [61]. The fruit is known as one of the best sources of natural vitamin C, which has been found to be more readily assimilated than the synthetic vitamin C. The fruit is also known to contain a significant amount of pectin, a complex polysaccharide containing galactoside residues, which are known to

possess anticancer properties. The antioxidant and strong reducing properties of vitamin C are known to be a free radical scavenger, suggesting its chemotherapeutic potential. The anti-inflammatory property of this fruit is also mentioned in Indian traditional medicine. The *in vitro* antitumor property against human leukemic cell lines, preliminary *in vivo* antitumor property against ehrlich ascites carcinoma, and the anti-inflammatory property of fruit extract, are being further evaluated in clinical studies [62].

White Chinese Olive

White Chinese olives (*Canarium album* Raeusch) (with Chinese name *Qing Guo*) have a pleasant and acrid taste. The fruits are usually made into preserved products. The major medicinal functions are to remove fever, purify the lungs, eliminate apprehension, stimulate appetite, promote salivation, and detoxify the body [20]. People usually use it for treatment of sore throat, thirst, restlessness, globefish poisoning, and alcohol intoxication.

Fruits of *Poncirus trifoliata* L. (*Gou Gi*)

In the ripe fruit of *Poncirus trifoliata* L. (with Chinese name *Gou Gi*), several substances have been isolated from this fruit, including poncirin, lemonin, imperatorin, bergapten, neohesperidin, citrifoliol and myrcene, camphene, and τ -terpinene [20].

Limonin has a chemopreventive effect against carcinogenesis, and can shorten sleep time. *Gou Gi* is used to treat gastric pain and constipation. It has been used with success to treat prolapse of the uterus or rectum.

Fruits of *Myrica rubra* Lour. Sieb. et Zucc. (*Gou Mei*)

Fruits of *Myrica rubra* Lour. Sieb. et Zucc. (Chinese name of *Gou Mei*) contain myricetin, a genin hydrolyzed from the glucoside myricitrin [20]. The fruit inhibits melanin biosynthesis, attributed to its inhibition of tyrosinase. It can be used as a whitening agent of the skin [63]. The fruit and myricitrin have antifungal and antibacterial activity. They can inhibit the growth of *Cladosporium cucumcimum*, *Bacillus subtilus*, and *Escherichia coli* [64]. This fruit is used to treat gastric pain, diarrhea, and dysentery.

Some Special Snack Foods — Preserved Fruits

Traditional methods of preserving fruits are by adding sugar, honey, salt, spices, and herb ingredients. These products are commonly called “preserved fruits,” “cured fruits,” or “candied fruits.” Fruits for preserving should be in the firm ripe stage. Cane sugar, beet sugar, corn syrup, honey, salt, and some herb or spice flavoring ingredients are commonly used. Preserved fruits are the most popular products among Asian people. Preserved fruits are excellently served with a variety of entrees, confections, and snacks to promote appetites.

There are several kinds of cured Chinese olives with different tastes and flavors: aroma preserved olive, multi-taste olive, sweet-preserved olive, sweet-preserved olive (*Soo Larm*), sweet-preserved olive (*Wo Sang Larm*), sweet-pre-served olive (*Lar chow larm*), sweet-preserved olive (*Wong Cho Larm*), and salted dry olive.

Preserved prune and plum (*Prunus salicina*) products are produced mainly in Southern China and Malaysia. The product has a sweet and sour taste, and can stimulate the appetite. There are several kinds of preserved prune and plum products with distinctive taste and flavor. They are sweet preserved prune, *chen-pee* (*Mei Prune*, *Chen-Pee Mei*), sea-soned prune, dried prune, salted preserved prune, half dried prune, preserved prune, brine-preserved prune, sweet prune cake, sweet-preserved plum (dried plum), sweet-preserved plum (*Poo Tow Lee*), seedless preserved plum, salted preserved plum, salted dried plum, half-dried plums, and brine preserved plum.

Red bayberries, also called *Yangmei* in China, are produced in Southern China. Preserved red bayberries have a dark-red color, and round shape.

Cured sweet orange or lemon peels are well-known products, mixing with a sweet herbal powder. The product has a multitaste, yellow-brown color, and high flavor.

Fruit leathers, known commercially as fruit rolls, are manufactured with fruit purees into leathery sheets. The leathers are eaten as a confection or used as a sauce. The dried products have a bright translucent appearance, chewy texture, and distinct fruit flavor. They can be prepared from a wide variety of fruits, including apple, apricot, banana, blackberry, cherry, grape, guava, hawthorn, papaya, peach, pear, pineapple, plum, raspberry, strawberry, and so on. Overripe fruits with high sugar and flavor but low fiber content are suitable for making fruit leathers.

SUMMARY

Fruits constitute an important part of the human diet. They are one of the main food resources that humans need to ingest daily. Most fruits are consumed fresh with little preparation. Approximately half is processed for year round consumption. Some fruit products are consumed directly as foods, while some are used as ingredients in confectionery, bakery, and diet foods. Some are also used in pharmaceuticals products.

Today, the food trend for the consumer is toward convenience and quality. This trend is best described as the “health-conscious” food preference. High-quality fruit products usually imply freshness with appealing flavor, color, texture, and appearance. Fruit products with

additional nutritive value and microbiological quality will offer consumers a healthy product containing natural sources of vitamins, minerals, and many health-promoting components.

Some of the health benefits from various functional components of more than 50 different fruits described here are based on time-honored tradition and observations, and some based on scientific studies and discoveries as elucidated in the references cited here. The key point is that all fruits and their products are a good source of vitamins (Vitamin C and carotenoids), antioxidants (flavonoids, polyphenols), and fiber.

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